



Human Effectiveness Directorate

USAF Scientific Advisory Board 1999 S&T Program Review Night Vision Device Training Research



**Air Force
Research Laboratory | AFRL**
Science and Technology for Tomorrow's Aerospace Force

**Dr Elizabeth Martin
Col Bill Berkley
Warfighter Training Research
Division**



Night Vision Device Training Research

Why is it Important?

- **AF real-world combat operations increasingly at night**
 - **USAF embraces a culture of “daylight operations” yet....**
 - » **We train during the day, we fight at night**
 - » **Only 15% of CAF RAP taskings are night oriented**
- **Night Ops Training Capability required for DMT & EAF**



Night Vision Device Training Research

Background Problem:

Objective: Approach:

- **Fielding NVGs without in-place training program**
- **Lack of USAF coordination for NVG implementation**
- **Enhance AF Night Operational capability & safety**
- **In-house and contract S&T in four areas:**
 - **Perceptual effects and training implications**
 - **Improved simulation of NVG imagery**
 - **Advanced instructional design**
 - **Night Ops human system integration for NVG users**
- **Laboratory and field research**
- **Extensive user involvement**
- **Joint service involvement (USN and USMC)**



Night Vision Device Training Research

- **Vision:** To assure that we
“OWN THE NIGHT”
- **Goal:** Provide comprehensive
night combat training capability



Payoffs

- **Increased night operational capability**
- **Decrease in NVG related mishaps**
- **Reduced aircraft training sortie requirement**
- **Reduced cost of training system acquisition & maintenance**
- **Improved risk management tools**
- **24 hour capability for DMT & EAF**



Interrelationships

- **Air Force Night Vision Working Group (MAJCOMs)**
 - **Executive Steering Group member**
- **AFOSR**
- **AATC**
- **USA NVESD**
- **USN PMA- 205**
- **NAWC-AD &TSD**
- **USMC MAWTS-1**
- **DTO HS 28: Distributed Mission Warfighting Training Technology and Techniques**
- **Industry & Academia**
- **International (UK, Australia)**
- **JSF**



Fly By Night Training Team

- **Col. Bill Berkley**
- **Dr Elizabeth Martin**
- **Maj Steve Hatley**
- **CDR Ryan Eichner**
- **Mr John Martin
engineer**
- **Mr Deke Joralmon**
- **Mr Joe Reigler**
- **Mr Jeff Clark**
- **Mr Craig Vrana**
- **Dr Celeste Howard**
- **Mr Motoo Uehara**
- **Mr Jeff Farinacci**
- **Mr Edgar Moreno**

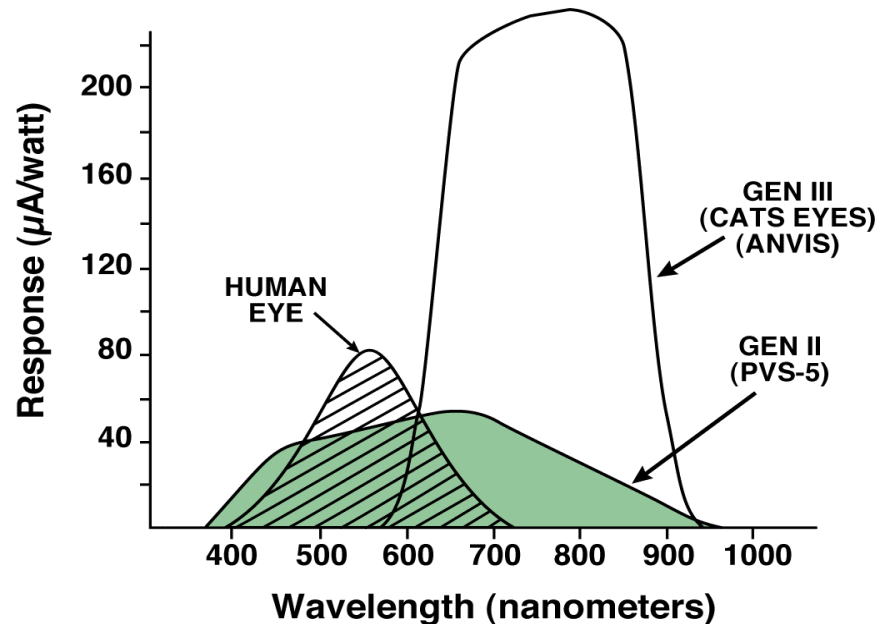
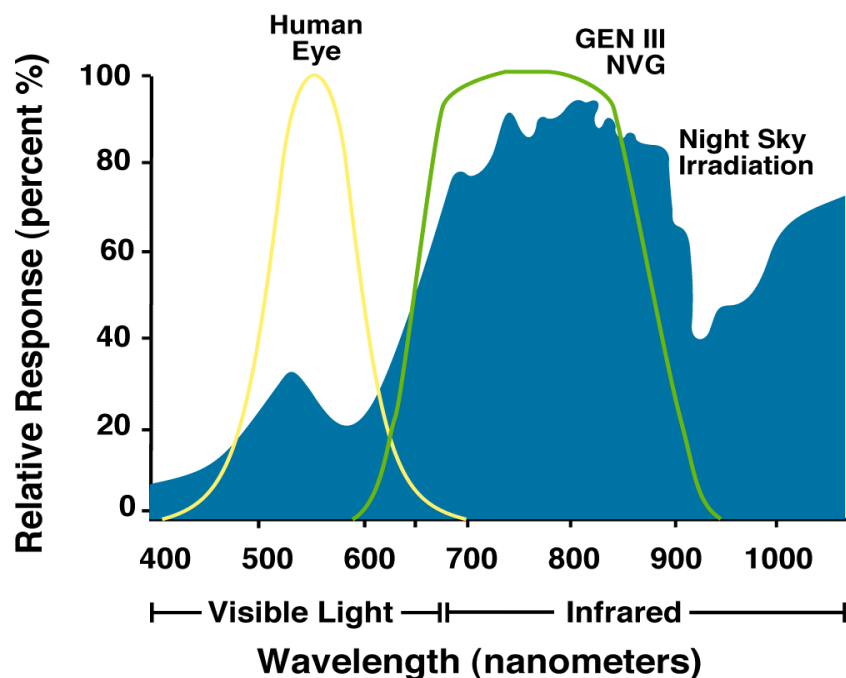
Flight surgeon
Behavioral scientist
NVG pilot
Physiologist
Night vision systems

Training Media specialist
Human Factors engineer
Software engineer
Display/integration engineer
Visual scientist
Integration engineer
Mathematician
Software mathematician



Perceptual Training Research

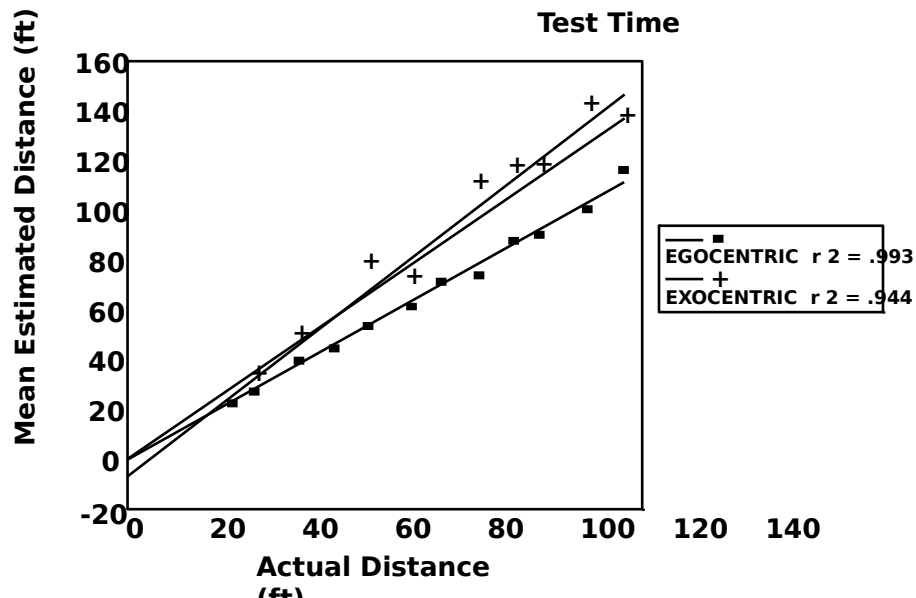
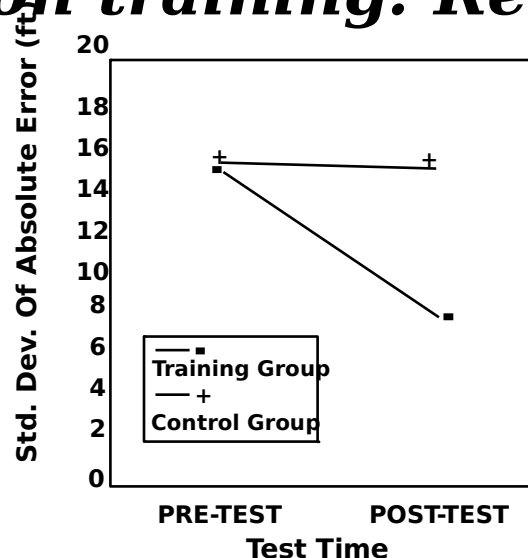
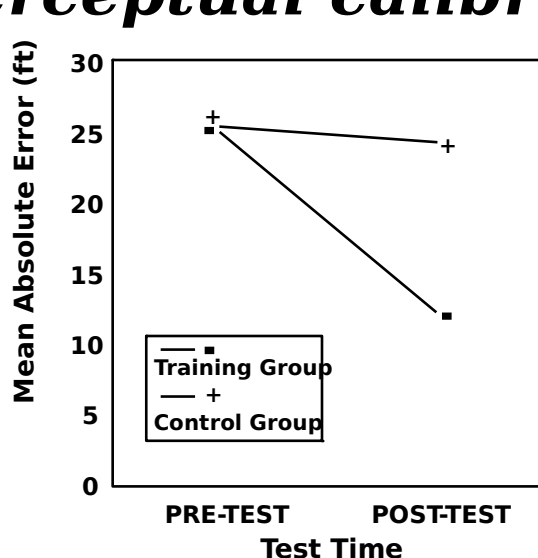
- **Aided (NVG) distance estimation**
- **Eye-head movement dynamics**
- **Mesopic light adaptation times**
- **Scanning/Task Management**





Distance Estimation Training with Night Vision Goggles

Perceptual calibration training: Results

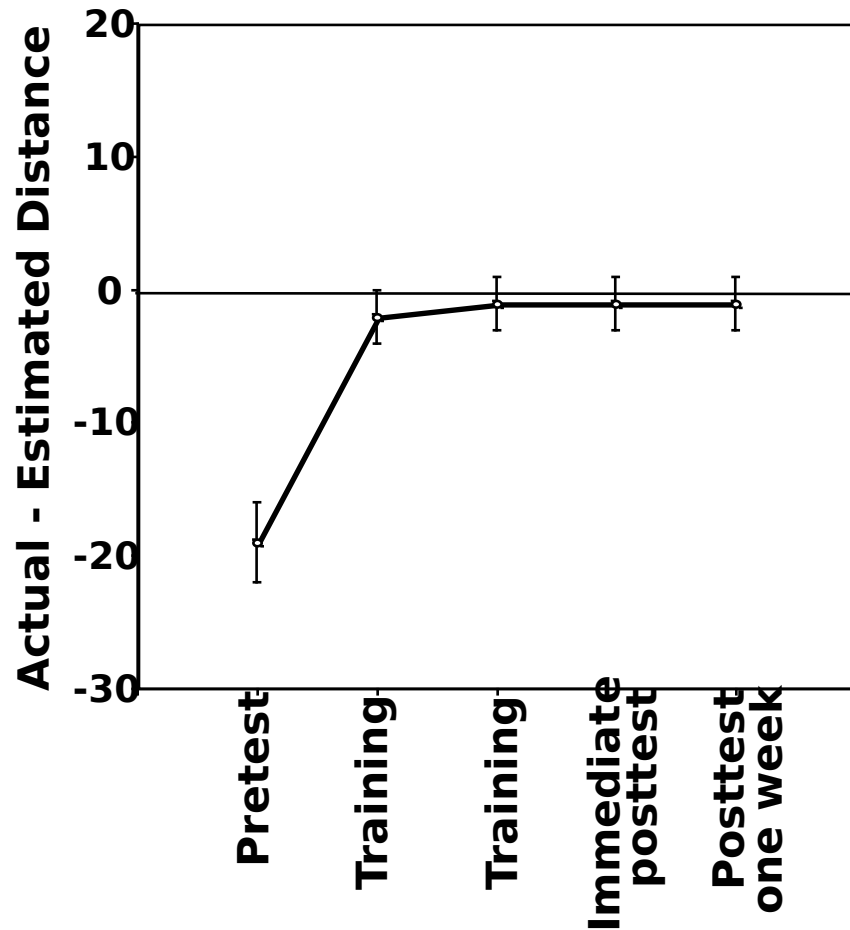


- Training improved performance
- Distance estimates were linear
- No difference between aviators and non-aviators
- Egocentric distances underestimated
- Potential individual bias towards underestimation



Distance Estimation Training with Night Vision Goggles

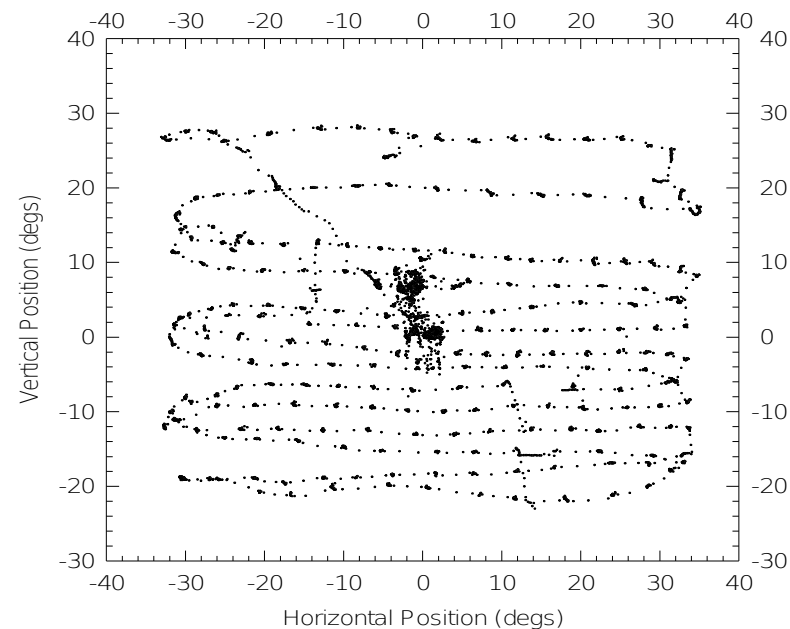
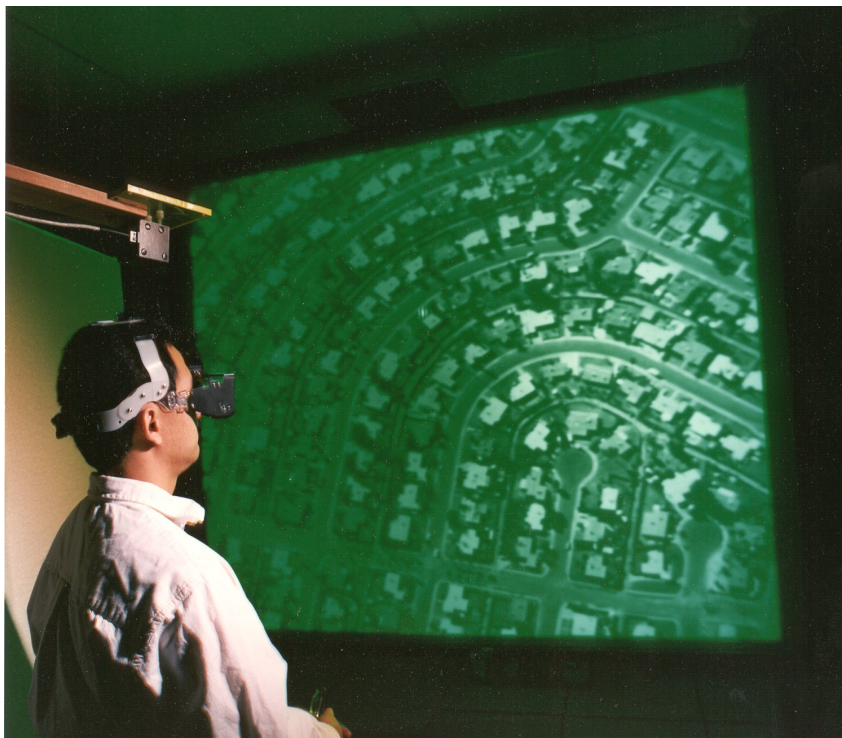
Feedback: Results



- **Performance improved**
 - **Errors reduced**
 - **Variation reduced**
- **Improvement retained for at least one week**
- **No difference between egocentric and exocentric distances**
- **Humans can learn to judge distance directly**



Coordinated Eye & Head Movement “Indoor” Visual Search



Two-Dimensional Search Pattern



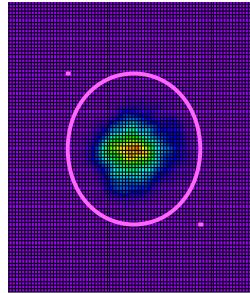
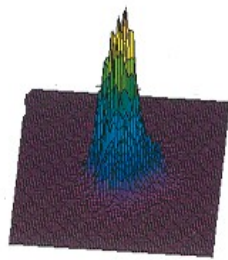
Coordinated Eye & Head Movement “Outdoor” Visual Search



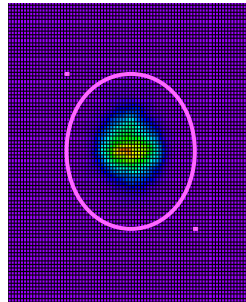
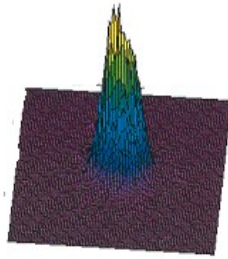
**Night Vision Goggles, Eye
and
Head Tracker**



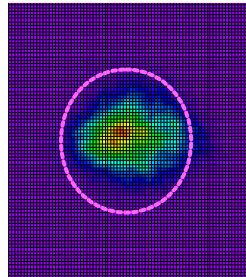
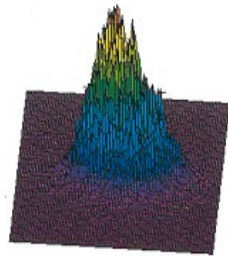
Combined Eye Position Surface Plots



**Simulated Daytime
40° FOV**



NVG aided 40° FOV



**Simulated
Daytime Unlimited
FOV**

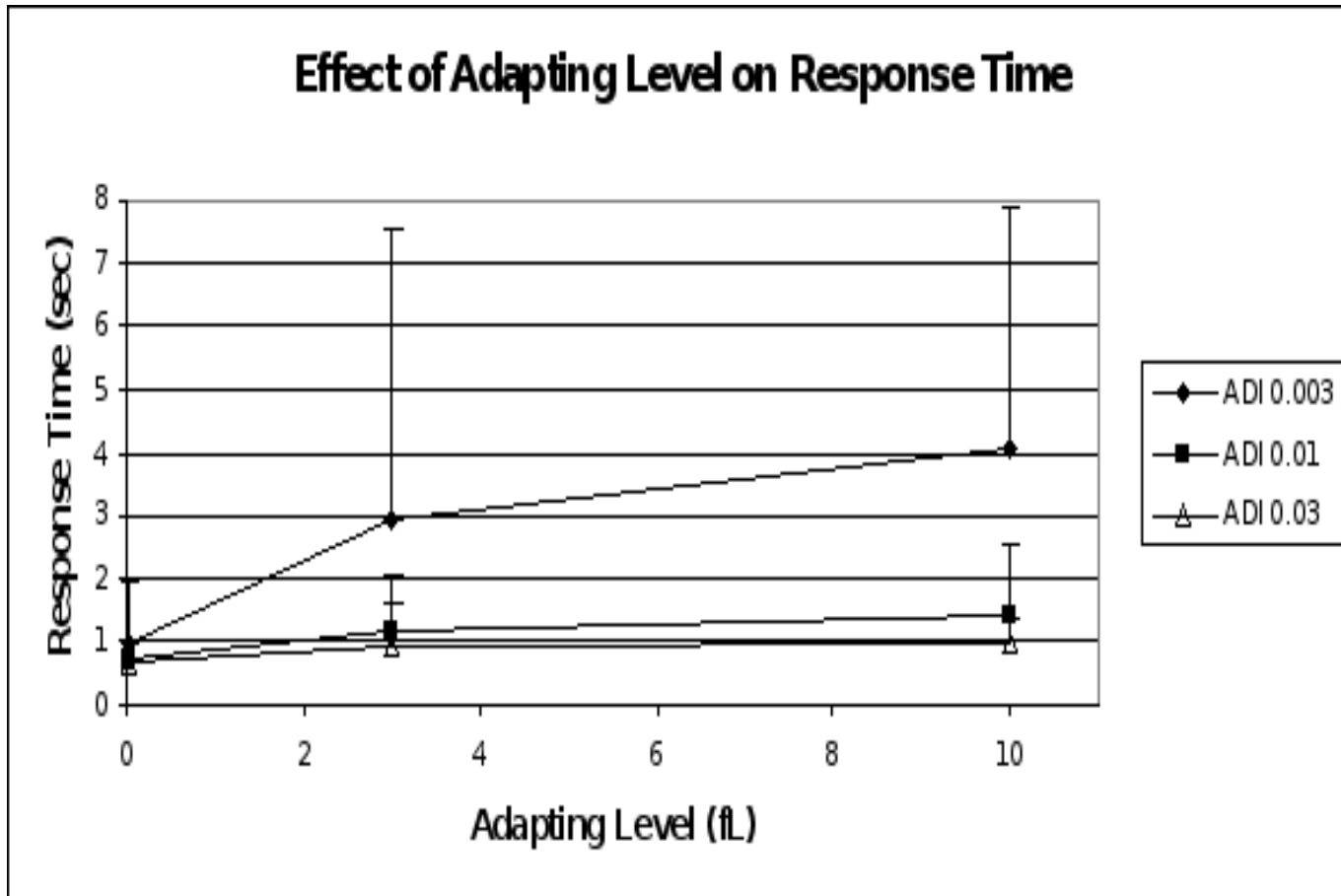


Head & Eye Movement Dynamics So What?

- **Dynamics are affected by FOV and NVGs**
 - **More restriction in size of saccades**
 - **More head movement**
 - **Timing altered**
 - **Large Individual Variability in Strategies**
 - **Some task dependency**
 - **Good methodology for future basic research**
- **Knowing head position is sufficient for developing scanning protocols**



Mesopic Light Adaptation





Mesopic Light Adaptation Times Significance

- **Additional time required to read primary flight instrument can range from 1.0 sec to 10 sec.**
 - **Impacts flight safety**
 - **Impacts scanning & task management procedures**
 - **May impact equipment set-up & design**
- **Training Research**
 - **Insert information into courseware**
 - **Develop procedures for practice of instrument scan and task**

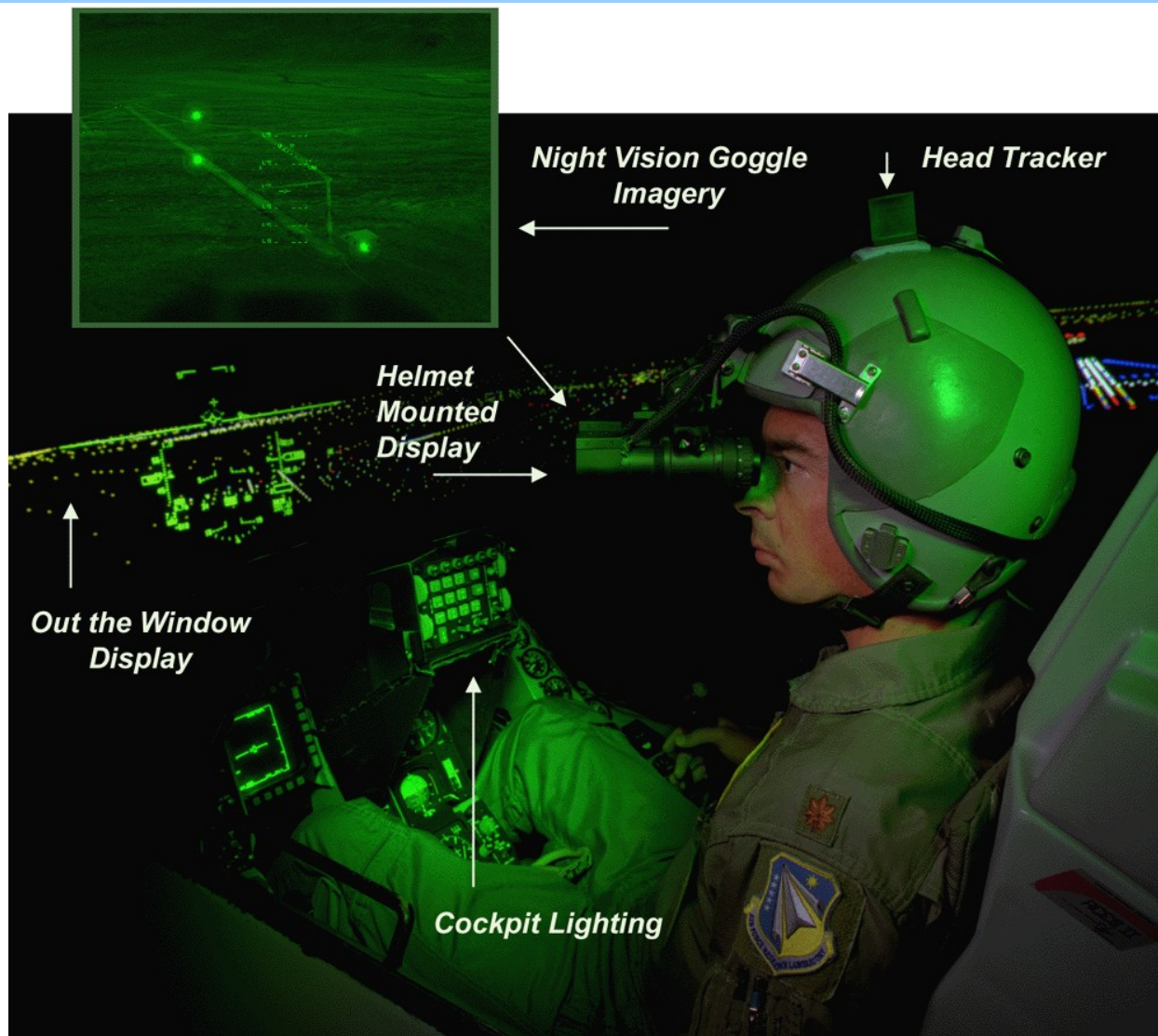


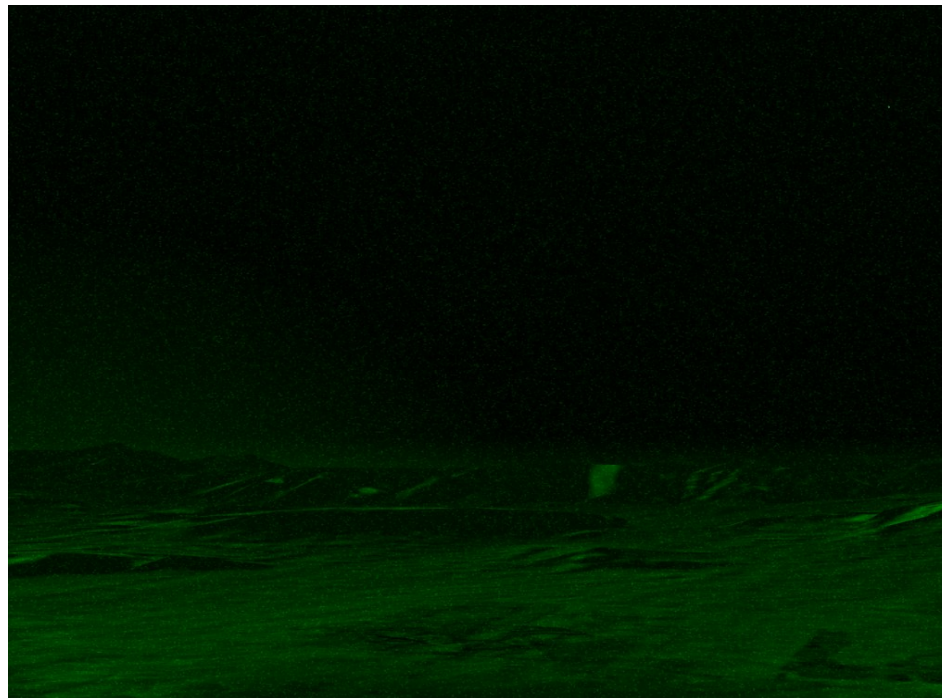
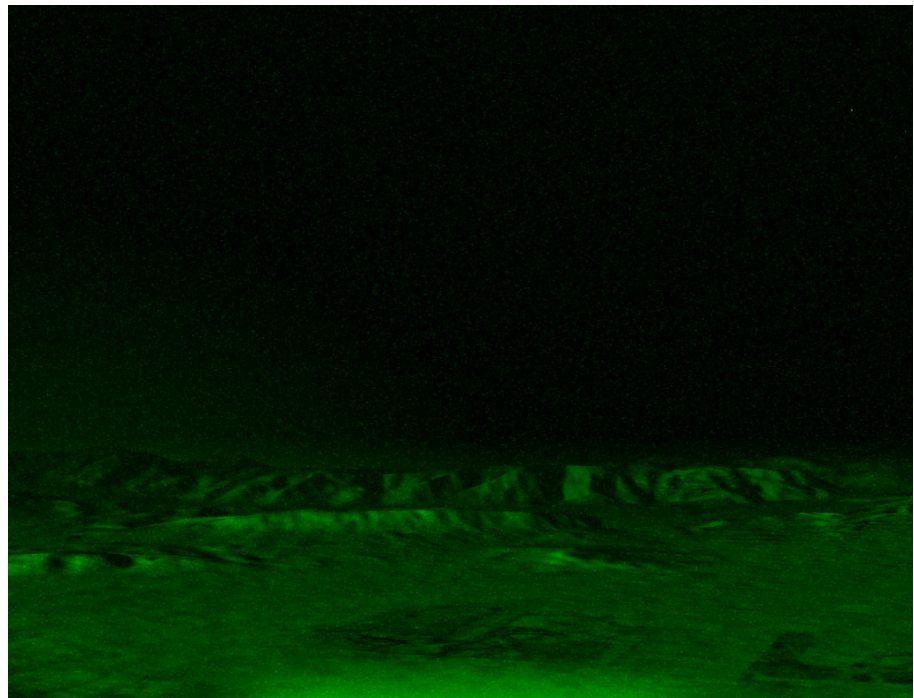
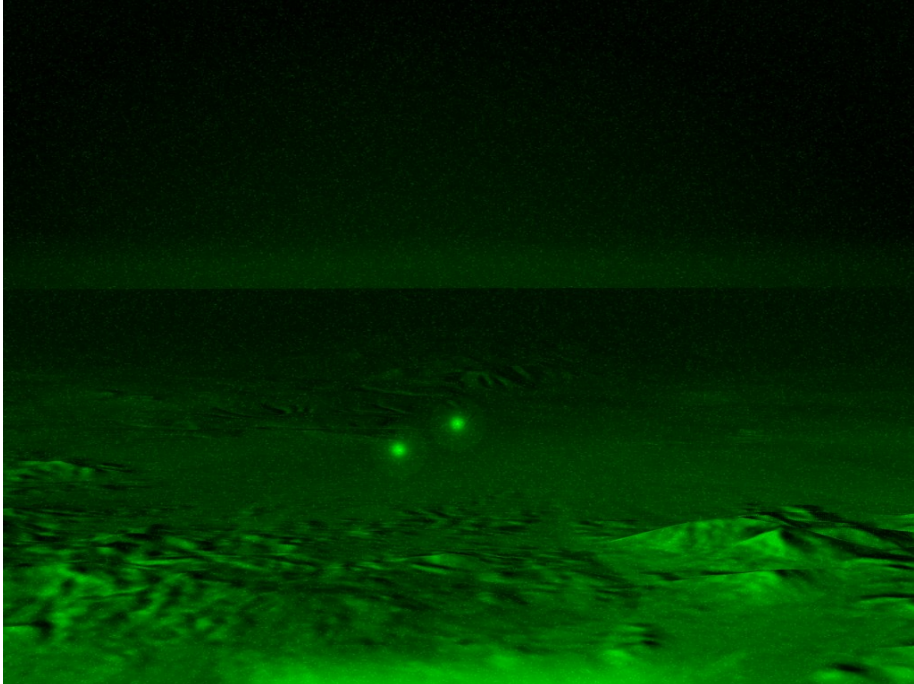
Simulation of NVG Imagery

- **Current State of the Art has limited training capability**
 - **Industry will not solve this problem:**
 - » **High risk**
 - » **Substantial development effort and cost**
 - » **Limited market**
- **Goal: Develop view of the world as seen with NVGs for realistic training**
- **Approach:**
 - **Develop NVG specific, physics based imagery**
 - **Quantify NVG performance characteristics required for simulation**
 - **Develop head-mounted CRT display with NVG form, fit, & function**
 - **Develop SensorHost (GOTS algorithms for sensor model)**
 - **Develop high resolution, multi spectral database requirements**
 - **Proof of concept demonstration**
 - **Lab and field test and evaluation**



Night Vision Training System







Prototype NVG Helmet Mounted Display





Advanced Instructional Design

- **Courseware for initial training USAF, USN & USMC**
- **NVG instructor course for USAF, USN, & USMC**
- **Design and validation of training facilities**
- **Lessons learned NVG mishaps module (fixed and rotor)**
- **Sensor Integration**
- **Digital “web-based” courseware administration**
- **On-line Courseware Development, Delivery & Administration**
- **Fused Sensors**

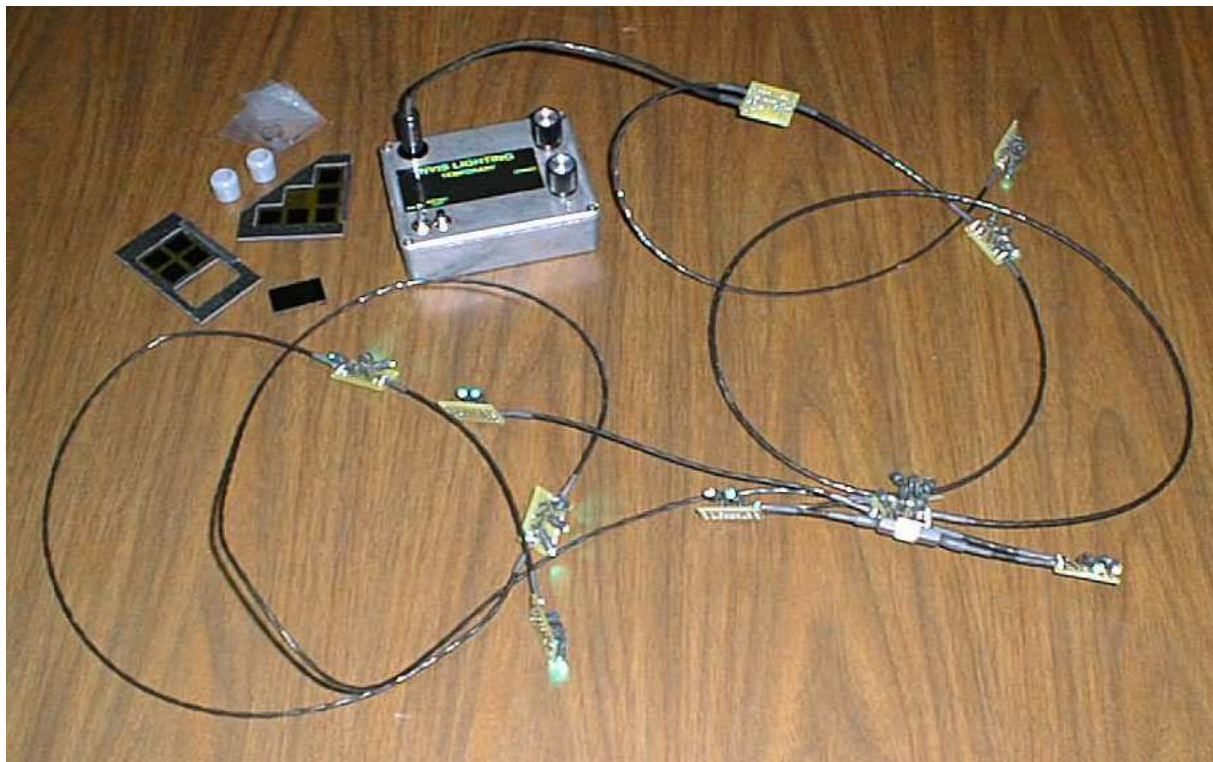


Night Ops Human System Integration

- **Aircraft lighting compatibility**
- **USAF, USN & USMC mishap investigations**
- **NVG Mishap Investigation Checklist**
- **Evaluation of laser eye protection devices and Air Commander's Pointer**
- **NVGs and associated equipment**
- **Development of LED-based interim cockpit lighting kits**
- **Development of external aircraft lighting standards**



F-16 LED String





Recent Accomplishments

- **Provided low cost interim NVG compatible lighting for operational combat forces**
- **NVG simulation system selected for use on AV-8B by USMC**
- **Demonstrated real time physics-based NVG simulation using material classification capability at the texel level**
- **Demonstrated 2-ship capability**



Transition

- **Cockpit/aircraft lighting:
appropriate aircraft SPO**
- **Mishap Investigations: Safety
Investigation Board**
- **Courseware: USN (MAWTS-1),
MAJCOMs**
- **NVG Simulation: USN PMA 205,
ACC, AMC, Industry**



When Are We Done?

Item

- **Distance Training/
Task management**
- **NVTS**
- **Advanced
Courseware**
- **System Integration**

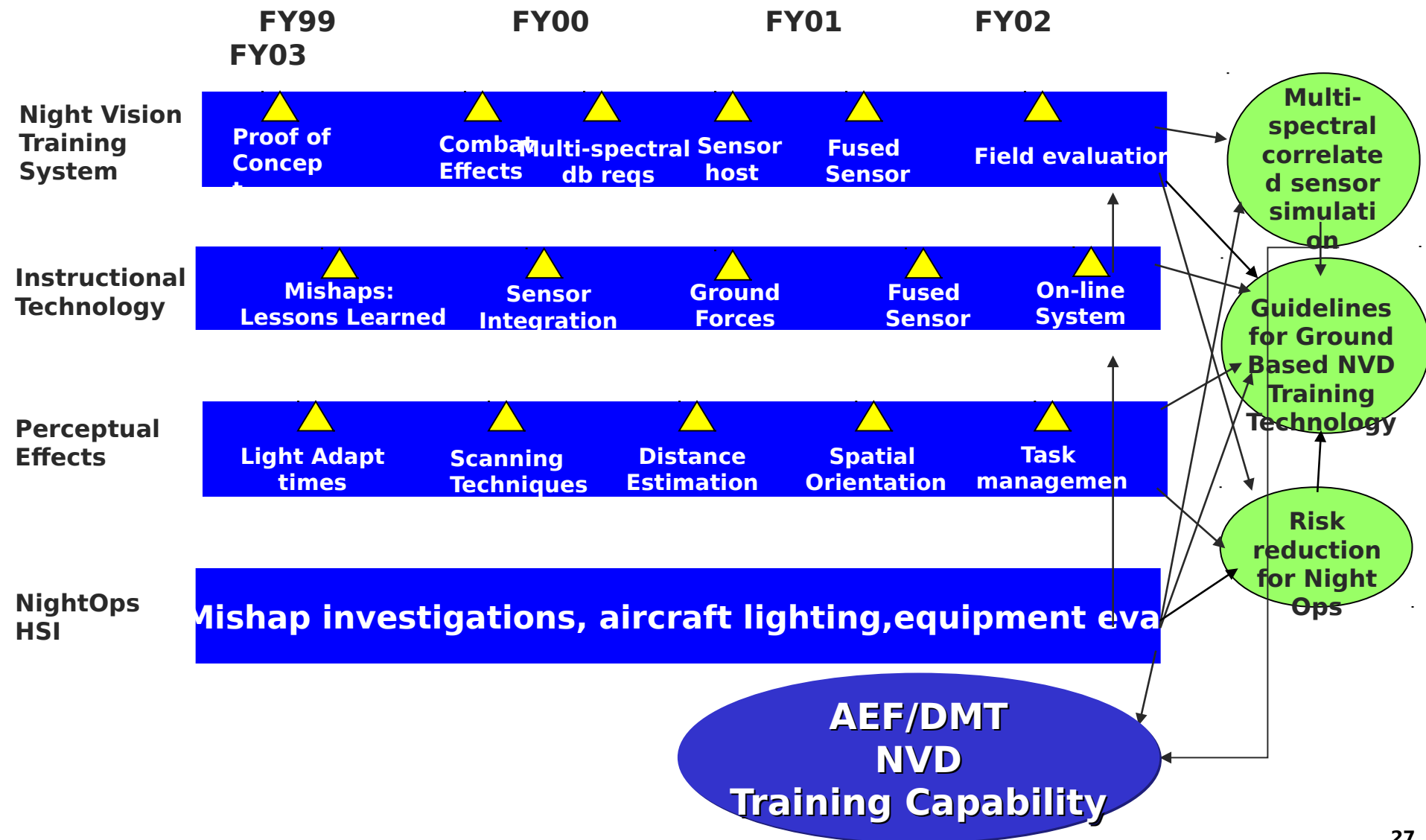
Exit Criteria

- **80% performance**
- **Validated SensorHost**
- **100% Digital Admin &
50% delivery**
- **All aircraft lighting
designs to SPO**





Technology Roadmap





Night Vision Device Training Research

Night military operations will receive even more emphasis in the future

Training at night will be limited by resources, airspace restrictions and time constraints

Cost effective, specialized DMT facilities, training systems and simulators WILL BE ESSENTIAL for EAF

